

dyskinesia following anterior ST-segment elevation myocardial infarction. This study takes advantage of a patient population with consistent follow-up within the same regional health system, managed at a high-volume academic center, and participating in a detailed prospective clinical database. In reviewing the report, however, we were left with a few questions; the answers to which might be of interest to other readers.

First, it is not clear to us from our reading of the paper how the propensity score was derived, for what clinical parameter propensity was determined (i.e., propensity for TATT vs. propensity for net adverse clinical events) (2), or how the propensity score was used to determine the net adverse clinical events odds ratio reported for warfarin therapy. Was this also part of the inverse-probability weighting multi-variable regression analysis?

Second, and somewhat related, it would seem, from the data presented, that anticoagulation with warfarin for apical dysfunction is the exception rather than the rule at this particular institution, with fewer patients treated and with TATT patients having more apical dysfunction, worse ejection fractions, and a 3-fold higher rate of cardiogenic shock. As such, we are left to wonder whether this retrospective analysis suffers from intractable confounding, which would explain the apparent paradoxical increase in non-hemorrhagic events in this group.

Finally, we would ask the authors to comment on both the timing of adverse bleeding events prior to hospital discharge (post-procedure vs. post-initiation of warfarin) and the decision to include these in the primary analysis. It would stand to reason that most patients in this group did not have a therapeutic International Normalized Ratio until the last day or 2 of hospitalization. A “back of the envelope” calculation suggests that the exclusion of in-hospital events would make the difference in outcomes between the 2 groups considerably less dramatic. Would a landmark analysis from the time of discharge have also achieved statistical significance?

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The Imperfections and Perils of Procedure-Based Risk Scores



Sherwood et al. (1) report that groups that perform more high-risk percutaneous coronary interventions have similar risk-adjusted mortality to those who perform fewer. The data are interesting, but a number of limitations preclude the final conclusion that adopting a more aggressive practice pattern will not increase risk-adjusted mortality.

Subgroups do not have uniform risk. Patients in cardiogenic shock have mortality rates that range from 22% to 88% (2). Physicians preferentially treat patients at the lower spectrum of risk and thus will have lower observed mortality than predicted by risk scores. At the same time, motivated practitioners have an incentive to “up-code,” which artificially inflates the estimated risk. The fact that in Sherwood et al. (1), “high-risk” cases tended to have lower-than-expected mortality is consistent with these limitations.

The conclusion also assumes that risk-averse operators are as adept as those who regularly perform high-risk cases. One of the benefits touted for public reporting is that it directs higher-risk cases towards superior operators (3).

A final limitation is the exclusion of patients who receive angioplasty at one site, but are then transferred to a different site. This excludes high-risk patients and procedural complications that might significantly alter the final results.

These limitations were not present at a Canadian regional care center, free of the medico-legal and public reporting concerns of the United States. In this setting, regional efforts to more aggressively treat high-risk myocardial infarction patients led to an increase in risk-adjusted mortality despite evidence for preserved procedural quality (4).

This debate also distracts from the more important issue. The real question is whether risk aversion related to public reporting results in public harm. This

analysis must include, not only those who undergo the procedure, but also those in whom the procedure was deferred. In 2012, Joynt et al. attempted to answer this question by exploring the outcomes of all patients with myocardial infarction in states that adopted public reporting, compared with those that did not. They found that in states with public reporting, mortality rates were significantly higher for patients presenting with ST-segment elevation myocardial infarction ($p = 0.004$) with a trend toward worse outcomes for the larger cohort of all patients with myocardial infarction ($p = 0.10$). More recently, this same approach was applied to a much larger population, revealing a dramatic 21% increase in mortality for patients presenting with myocardial infarction in states with public reporting ($p = 0.013$) (5). This was driven primarily by an increase in mortality in patients in whom intervention was deferred. With these results, we must conclude that public reporting of procedural outcomes results in public harm.

We applaud Sherwood et al. (1) for their efforts. At the same time, we wonder whether the time has come to move away from procedure-based risk scores and toward diagnosis-based databases that examine the outcomes of all patients, not just those subgroups selected to undergo specific procedures.

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Left Atrial Appendage Closure Guided by Personalized 3D-Printed Cardiac Reconstruction



Percutaneous left atrial appendage occlusion (LAAO) with the Watchman device (Boston Scientific, Natick, Massachusetts) is currently conducted under fluoroscopic and transesophageal echocardiographic guidance. Multidetector computed tomography (MDCT) acquires a 3-dimensional (3D) dataset that provides better spatial resolution, allows unlimited reconstruction, and enables more precise procedural planning than 2-dimensional (2D) imaging (1,2). Nevertheless, the complex dimensions of the left atrial appendage and its variable morphology may result in procedural failure despite careful planning (3).

Three-dimensional printing (also known as rapid prototyping) allows an exact replica of a patient's anatomy to be created in a variety of materials, which may replicate underlying tissue characteristics. We describe the use of a patient-specific model to guide a left atrial occlusion procedure using the Watchman device.

A 74-year-old man with a history of paroxysmal atrial fibrillation and a CHA₂DS₂VASc score of 6, cerebrovascular events, ischemic cardiomyopathy, and intolerance of anticoagulation was referred to our institution for consideration of transcatheter LAAO.

In preparation for the procedure, MDCT of the left atrium and left atrial appendage, gated to atrial diastole, was performed. Semiautomated segmentation (Mimics v17.0, Materialise Software, Leuven, Belgium) generated a stereolithography file that was printed in a rubber-like material to simulate atrial mechanical properties (Tango Plus Material, Shore hardness 27A, Stratasys Objet Connex 500 printer, Stratasys, Eden Prairie, Minnesota). Watchman devices in sizes of 21 mm, 24 mm, and 27 mm were placed in the model, which was reimaged using clinical CT. Virtual rendered images were generated using Ziosation (Qi Imaging, Redwood City, California) (Figure 1A).

The imaged 3D printed replica atrial appendage with the devices in situ (Figure 1B) was analyzed (3-Matic 9.0, Materialise Software), and the anatomic deformation was calculated for each device, creating a 3D map color-coded according to the degree of deformation caused. This demonstrated the areas and extent of engagement of the device on the flexible atrial model.